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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : B21D 5/08 — A1

(11) International Publication Number: WO 87/ 01977

(43) International Publication Date: 9 April 1987 (09.04.87)

(21) International Application Number: PCT/AU86/00306

(22) International Filing Date: 6 October 1986 (06.10.86)

(31) Priority Application Numbers: PH 2748, PH 6067

(32) Priority Dates: 4 October 1985 (04.10.85), 23 May 1986 (23.05.86)

(33) Priority Country: AU

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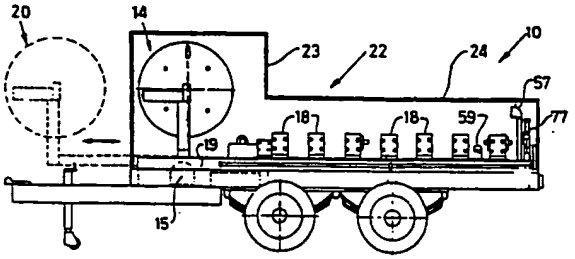
(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BG, BR, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CM (OAPI patent), DE, DE (European patent), DK, FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.

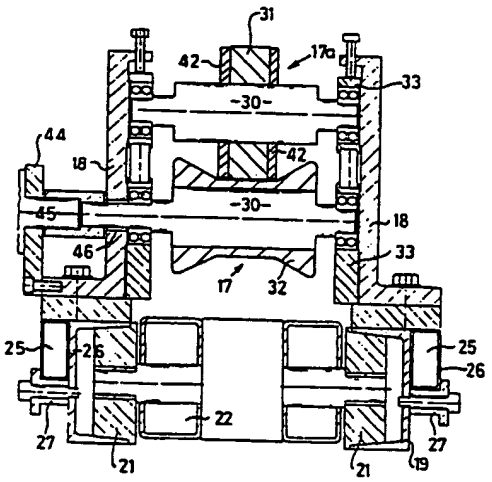
Published
With international search report.

(54) Title: ROLL FORMING MACHINES

(57) Abstract

Apparatus (10) for the roll forming of sheet metal components wherein a plurality of roll forming stations (12) are mounted on a support frame (18, 19, 33), each station having a pair of complementary forming rollers (17, 17a). Individual drive motors (16) are connected to selected roll forming stations in conjunction with associated control means (57) for drive control of those motors (16) in accordance with the driving load that is placed upon the forming rollers (17, 17a).





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"ROLL FORMING MACHINES"

This invention relates to roll forming machines.

In particular this invention relates to roll forming machines which may be mounted on a trailer or the like for on-site roll forming of metal components. However this invention can be applied to fixed roll forming machines.

On-site roll forming of metal building components has gained widespread acceptance because full length components can be formed on site to suit a particular application. This minimises erection time and the number of joints required to be made and of course warehousing of manufactured components is not required. The presently available roll forming machines however may be difficult to set up or relatively inefficient in terms of power usage. Manual control is often required for the apparatus and this frequently leads to wastage of metal through cutting a component too short or too long. Furthermore most roll forming machines are not tolerant to gauge variations in the metal being roll formed. This may necessitate adjustment of the apparatus each time a new coil of feedstock is loaded into the machine.

Aspects of the present invention aim to alleviate the abovementioned disadvantages and to provide roll forming apparatus which will be reliable and efficient in use. Other objects and advantages of this invention will hereinafter become apparent.

With the foregoing and other objects in view, this invention in one aspect resides broadly in roll forming apparatus including:- a plurality of roll forming stations mounted on a support frame; each said roll forming station having a pair of complementary forming rollers; a driving motor connected to selected roll forming stations, and control means associated with said driving motor whereby said driving motor may drive the rollers of said selected roll forming stations in accordance with the driving load placed upon said

forming rollers. Preferably the driving motors are hydraulic motors but if desired they could be pneumatic motors or suitable electric or fuel motors or the like. The driving motors may be manually adjusted to provide the required driving power but preferably each driving motor is provided with a power control circuit including a programmable master controller adapted to control the driving power applied to the selected roll forming stations. For this purpose a load sensing transducer may be associated with each driving motor and adapted to monitor the load thereon and to provide appropriate control signals to said master controller.

In a preferred form driving motors are connected to selected ones of the roll forming stations and the forming rollers of the roll forming stations intermediate the selected driven roll forming stations are adapted to rotate freely.

Preferably the forming rollers in all or some of said roll forming stations each include a rigid support shaft which extends across the roll forming path and a roller body mounted thereon and formed of a resilient material such as a plastics material. In the preferred form the plastics material is a polyurethane material having a hardness of approximately 80 to 120 Durometer. These rollers may have a surface finish of between RA 10 and RA 15. Of course these values of hardness and surface finish may be varied to suit particular applications. It is also preferred that the roller in each station about which bends are formed are provided with a steel disc on the support shaft extending outwardly to a position adjacent the outer surface of the roller body and having a radiused corner about which the fold line for the corner is formed. Preferably, the plastics roller body extends outwardly beyond the metal discs a distance of about one half millimetre but this may be increased up to one millimetre or more if desired.

The upper and lower support shafts at each roller station are so mounted that the adjacent roller body surfaces

engage drivingly with the lightest gauge feedstock to be used in the roll forming apparatus and the hardness of the roller bodies is such that they may be compressed when a heavier gauge sheet material is introduced between the rollers so that a single roller setting may be utilized for roll forming sheets of various thicknesses. For this purpose, the rollers at each roll forming station are supported on respective bearing mountings at each end thereof which are restrained for vertical sliding movement on mounting brackets secured to the base structure or support frame. The bottom bearing mounting is adapted to abut the base structure while the top bearing mounting is restrained against upward movement by an adjustable abutment means which may be in the form of a bolt threadedly engaged with a lug on the mounting bracket. Resilient spacer means may be supported between the bottom and top bearing mountings to maintain them in their operative spaced apart relationship.

The roll forming assembly described above utilizes roller bodies formed of plastics material and driven by hydraulic motors which supply driving power in accordance with the load requirements. Accordingly, slip between the roller bodies and the feedstock being roll formed is substantially eliminated or minimised to such extent that encoder means may be provided on a roller body and in particular a freewheeling roller body to provide an output signal to a master controller which may interpret the signal as length of product formed. The master controller may be programmable for required length and number of units and thus the machine may operate automatically to produce roll formed pieces to selected lengths and in selected quantities.

Any suitable form of shearing means may be provided to cut the formed sections to length. However it is preferred that the shearing means be of the type which removes or punches out a billet as opposed to a guillotine type shear, but of course the latter may be used if desired. However when

a pair of roll forming machines are provided in spaced side by side relationship on a trailer assembly and each controlled by the common controller, it is preferred that each shear be of the same type. If of billet shear type as described above, it is preferred that each removes a billet of the same width to facilitate accurate length monitoring by the common controller of cut pieces from both roll forming machines.

The automatic controller is preferably formed as a detachable unit with plug-in connections to the various switching, valve and sensing apparatus. Preferably it is mounted on a carrier whereby it may be moved to an operative position at which it may be easily viewed by an operator. The automatic controller preferably has provision for automatic and manual feed of the roll forming apparatus and automatic and manual control of the shearing apparatus. Preferably it is programmable for length and numbers of pieces to be produced.

The controller may also have a totalising count for stock control and provide automatic control of power or torque input by the driving motors of the respective roll forming machines. If desired the automatic controller may have security locking of the programme to prevent accidental tampering and a printer for providing a printout of production or any required information. The controller may also have means for inputting cost per metre of finished product such that it may provide automatic charge out calculations for job costing. It is also preferred that the control means be provided with a visual display for programming guidance and monitoring production as well as voice command for start stop functions or for programming guidance.

The roll forming apparatus according to the present invention are preferably trailer mounted to allow the apparatus to be towed to a site at which the roll formed products are to be used. The trailer preferably comprises a frame and a tandem or single wheel suspension assembly of

conventional design. An enclosure is preferably provided on the trailer to enclose the roll forming machine or machines and the enclosure preferably includes a plurality of openable or removable panels to allow access to the or each roll forming machine such that it may be readily operated and adjusted or repaired. Of course if desired a chain drive or other conventional drive arrangement may be utilized to supply drive to the rollers and if desired each roller station may be driven.

Accordingly, in another aspect, this invention resides broadly in roll forming apparatus having a plurality of roll forming stations and drive means for actuating the roll forming stations, wherein the forming rollers in each or some of the roll forming stations each include a spindle having a resilient body supported thereon. In the preferred form the plastics material is a polyurethane material having a hardness of approximately 80 to 120 Durometer. These rollers may have a surface finish of between RA 10 and RA 15. Of course these values of hardness and surface finish may be varied to sit particular applications. It is also preferred that the roller in each station about which bends are formed are provided with a steel disc on the support shaft extending outwardly to a position adjacent the outer surface of the roller body and having a radiused corner about which the fold line for the corner is formed. Preferably, the plastics roller body extends outwardly beyond the metal discs a distance of about one half millimetre but this may be increased up to one millimetre or more if desired. Of course this may be varied with different hardness roller bodies.

In a further aspect this invention resides in a forming roller for roll forming apparatus and having a body formed of elastomeric material as defined above.

In order that this invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawings which illustrate one form

of roll forming apparatus incorporating a pair of roll forming machines for producing complementary roll formed sections from coils of metal strip supported within the apparatus and wherein:-

FIG 1 is a typical perspective view of a mobile roll forming machine made according to this invention;

FIGS 2 and 3 are perspective views of the mobile trailer for the roll forming apparatus;

FIGS 4 to 6 illustrate the general layout of the roll forming machines and the metal feedstock strip decoilers;

FIG 7 is a typical cross sectional view through the bed of one of the roll forming machines;

FIG 8 is a side view illustrating the method of attachment of a pair of rollers to the base frame of a roll forming machine;

FIG 9 is an enlarged partly broken away view of a pair of forming rollers;

FIGS 10 and 11 illustrate in plan and side elevational views the preferred form of shearing means;

FIG 12 is a schematic of the hydraulic circuit;

FIG 13 is a schematic of each motor control;

FIG 14 illustrates the panel layout of the automatic machine controller, and

FIG 15 and FIG 16 are schematics of the control circuit.

As shown in FIGS 1 to 6, the roll forming apparatus 10 comprises a trailer 11 on which is mounted a pair of roll forming machines 12 and 13 having parallel roll forming paths extending longitudinally along the trailer 11. Decoiling apparatus 14 for the feedstock coils is supported at the leading end of the trailer 11 and each is adapted to provide strip metal for a respective roll forming machine 12 and 13. Suitable metals include steel, galvanised steel, aluminium,

zincalume and painted steel. The width of the sheet or strip and its gauge will depend upon the nature of the finished product and use to which the finished product is to be put.

As the illustrated roll forming apparatus 10 according to this invention is trailer mounted the decoiler 14 is preferably disposed on the trailer adjacent a towing vehicle and is slidably mounted relative to the trailer such that the decoiler may be moved into close proximity to the towing vehicle if desired. This allows heavy coils of feedstock to be loaded onto the decoiler directly from the towing vehicle without the need for the coils to be lifted in any way. When the decoiler has been loaded with a coil of feedstock it may then be slid back into place and the feestock fed to the forming rollers.

In this embodiment each roll forming machine 12 and 13 is provided with seven roll forming stations between which the metal strip passes for stepwise forming to the required profile. However for simplicity, details of only one roll forming machine is illustrated. A common hydraulic pump 15 driven by an electric motor is supported intermediate the two decoiling apparatus 14 and it is adapted to supply hydraulic fluid to the hydraulic motors 16 coupled to respective lower forming rollers 17 of selected roll forming stations.

As can be seen in FIG 7, the upper forming rollers 17a and the lower forming rollers 17 of each machine 12 and 13 are supported between respective pairs of spaced apart supporting brackets 18 mounted on longitudinally extending main beams 19 which provide a stiff mounting base for the rolling stations to ensure accuracy of roll forming. The main beams 19 comprise a pair of spaced channel members arranged with their open faces opposing one another so as to form rails for the guide wheels 21 of a decoiler carriage 22 which is longitudinally reciprocable to enable the decoiler to be moved from an operative attitude within the leading raised portion 23 of the enclosure 24 to an unloading/loading position in

front of the enclosure 24, as illustrated in dotted outline at 20. Suitable stops and locking means are provided for maintaining the decoiler in its operative attitude.

A further retractable carriage 25 is supported by the main beams 19. This carriage 25 has spaced rectangular rails 26 carried on wheels 27 secured by stub axles to the outermost web of the main beams 19. The rear or outer ends of the rails 26 support a guide roller 28 which in turn is adapted to support the rollformed section as it runs rearwardly from the respective roll forming machine 12 or 13. Each run out or guide roller 28 may be slid outwardly to a desired distance from the back of the respective roll forming machine 12 or 13 to suit the length of the article being formed.

As shown in FIG 9, the forming rollers 17 and 17a comprise a steel supporting shaft 29 having an enlarged hub portion 30 about which the polyurethane roller bodies 31 and 32 are moulded. For this purpose the surface of the hub portion 30 is roughened or splined or otherwise formed so as to key into the roller body 31 or 32. Each roller shaft 29 extends between the respective pair of supporting brackets 18 which support slidable bearing carriers 33 between opposed abutments 34. The carriers 33 are retained for vertical sliding motion between the abutments 34 by detachable slide retainers 35. A compression spring 36 is supported between the respective bearing carriers 33 and an adjustment bolt 37 is adjustably engageable with the top face of the uppermost bearing carrier 33 so as to enable the spacing between the outermost portions of the adjacent roller bodies to be selectively adjusted. This arrangement is illustrated in FIG 8.

Each roller 17 and 17a has a roller body portion which is formed of polyurethane material. In this embodiment the polyurethane material has the following specifications.

PHYSICAL PROPERTIES.

Formula:.....PU 50

Colour:.....Black
Hardness Durometer:.....95 (shore A)
Tensile Strength (at 300% strain)...26.88 MPa
Elongation:-.....375%
Tear Strength:.....93kN/m
Machine Finish:.....Ra 12.5 micrometre

The illustrated rollers are intermediate rollers in a rolling path adapted for forming a channel section. At the station illustrated, the rollers are adapted to fold the flanges 38 of the channel thirty-six degrees upwardly beyond the horizontal. For this purpose the lower roller body has a central cylindrical section 39 and frusto conical end portions 40. A retaining lip 41 is provided to maintain the strip in a central position relative to the rollers 17.

The whole of the roller body 32 of the lower roller 17 is formed of polyurethane while the upper roller 17a has a central polyurethane section 41 extending between spaced annular metal discs 42 fixed to the support shaft 29. The central cylindrical section 41 extends outwardly beyond the discs 42 a distance of approximately one half millimetre whereby the strip being formed does not engage the steel flanges 42 other than at their outermost radiused corner portions 43. This provides a consistent bend line between the base and the side wall of the channel formed.

In the roll forming machine 12, four hydraulic motors 16 are coupled directly to the first, third, fifth and seventh lowermost rollers 17. The upper rollers 17 are freely rotatable. Each motor 16 is carried on a motor mounting 44 fixed to the base flange of the bearing mounts 18 whereby the output shaft 45 of the drive motor may couple directly to an extension of the lower roller shaft 29 which is adapted to pass through an aperture 46 in one supporting bracket 18. The forming rollers 17 and 17a at stations two, four and six rotate freely with the strip of metal being formed as the latter is fed therebetween.

As can be seen from the hydraulic circuit 50 in FIG 12, the pump 15 provides a common supply from the reservoir 58 to servo valves 51, 52, 53 and 54 which control the motors 16, the shears cylinder 55 and a further punch cylinder 56 respectively. The latter may be used to form apertures or the like at desired spacings in the section being formed. The servo valves 51, 52, 53 and 54 may be manually controlled, however in this embodiment they are coupled to the automatic controller 57 which may be programmed to operate the roll forming machines 12 and 13 to produce the required products.

Each hydraulic motor 16 is connected between the feed and return lines 48 and 49 through a series connected servo valve 60 and a load sensing transducer 61 which is connected through a signal amplifier 62 to the automatic controller 57 which, in addition to providing the automatic feed and shear controls is programmed to regulate hydraulic fluid supply to the respective motors 16 through the servo valve 60 in accordance with the load requirements sensed by the transducer 61.

The automatic controller 57 is mounted within a housing 63 which is normally concealed within the outer end portion of the enclosure 24. It may be slid outwardly to provide clear working access thereto. The controller 57 is provided with sockets on its back face for plug-in connection of the inputs from the motor torque sensors and a shaft encoder 59 coupled to a freewheeling lower roller 17 so as to monitor the length of strip material fed between the rollers. Other connections for power etc are also plug-in for ease of maintenance and for convenience of manufacture. To this end the enclosure 24 may be formed of fibreglass reinforced plastics material and the rear section can comprise a pair of identical sections as shown at 8 and 9 in FIGS 1 to 3.

The front panel 64 of the controller 57 is illustrated in FIG 10. It includes a six digit LED display 65 with programmable decimal point, a keyboard 66, function keys

67, 68, 69 and 70 for count, function, reset and enter respectively and yellow light bars 71 which indicate if the display is showing the count value. A printer 72 is arranged in the lower portion of the control panel 64. A hand control 73 with cut and feed buttons 74 is mounted on the control panel so that at any time the roll forming machines can be manually controlled. As shown in the schematic in FIG 16, separate P.C. units 75 and 76 are provided for programming the counter units and the length units respectively. Voice control switching 77 is also provided.

The automatic controller as illustrated in FIGS 15 and 16, functions either as a "RESET to PRESET" control with outputs occurring when the count reaches zero or a preset, or a "RESET to ZERO" control with outputs occurring when the count is equal to one or the other of the two preset numbers. The controller 57 also provides a second internal counter which can be used as a batch totalizer to count how many cycles the unit has performed. Additionally, a batch preset is set up to allow control of batch quantities. A third output is provided for batch control. The controller 57 also features the ability to scale incoming counts. Thus for each pulse received on the count inputs, a fraction or multiple of that pulse is indicated on the display. The scale factor can be a number from 0.0001 to 9.9999. This number becomes a factor by which incoming count pulses are multiplied. The result of the multiplication is shown on the front panel display.

A non-volatile memory ensures that the set-up instruction will not be lost if power is interrupted. Count and batch values will also be retained if a power loss interrupts a process or machine cycle. The front panel of the controller 47 is framed by a bezel that seals the panel to the mounting surface.

The keyboard consists of ten data keys (0 through 9), "COUNT" key, "RESET" key, "FUNCTION" key and "ENTER" key. The

"1" data key also serves as the "PRESET 1" key and the "2" key also serves as the "PRESET 2" key. The "6" data key serves as the "BATCH PRESET" key and the "7" data key as the "BATCH COUNT" key. The upper right portion of the front panel contains four yellow LED indicators for COUNT, PRESET 1, PRESET 2 and BATCH operation. The panel mounted printer 72 is a 24-column panel printer and features a standard port for interface with a wide range of computer-based equipment. The serial port is directly compatible with the micro-processor based digital panel control. A standard two-line buffer is provided. The printer 72 also incorporates an error detection system for uncomplicated operations. The test button may be pressed to print out all ninety-six characters for periodic checks. Front panel lights indicate power on, and out of paper. A flashing paper light provides immediate alert to any printing problems. If anything interferes with data output, the printer will indicate appropriately. Of course the automatic controller of this invention may be used for controlling other processing equipment as required.

In use an operator may select automatic or manual feed and shear. In automatic mode, the operator may programme the automatic controller for length measurements and number of items required. The operator may then actuate the machine which will automatically produce and cut to length the desired number of roll formed sections.

A further advantage of the roll forming apparatus described above is that embossing rollers may be arranged at the leading end of the roll forming path so as to emboss the sheet with a suitable pattern, such as a woodgrain pattern, prior to the sheet passing between the resilient rollers in the roll forming path for formation into any desired article such as siding, guttering, fence panelling or roofing. However if only parts of the section is to be embossed the embossing rollers can be arranged at the trailing end of the roll forming path. This arrangement has the advantage that

the embossing removes any "oil can" effect which may be formed during rolling. Alternatively a crowned roller can be used to achieve the same effect.

As previously mentioned the shears 77 as illustrated in FIGS 10 and 11 are provided with spaced guide plates 78 and 79 which are apertured at 80 to permit the formed section 81 to pass therethrough. A pointed shear blade 82 is slidably reciprocable between the plates 78 and 79 so as to shear the section 81 against each plate and thus remove a billet and provide a neat cut at each end of the section. The blade 82 is actuated by the hydraulic ram 55. The use of the hydraulic power source, also offers the additional advantage that this same power source may also be used to power presses or the like mounted on the machine. Such presses may be used for stamping holes in roll formed components or for forming clips, brackets or the like used for joining roll formed products together or to drive auxiliary power tools.

It will of course be realised that the above has been given only by way of illustrative example of the present invention and that all such modifications and variations thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of the invention as is defined in the appended claims.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. Roll forming apparatus including:- a plurality of roll forming stations mounted on a support frame; each said roll forming station having a pair of complementary forming rollers; a driving motor connected to selected roll forming stations, and control means associated with said driving motor whereby said driving motor may drive the forming rollers of said selected roll forming stations in accordance with the driving load placed upon said forming rollers.

2. Roll forming apparatus according to Claim 1, wherein each said selected roll forming station is connected to a respective driving motor.

3. Roll forming apparatus according to Claim 2, wherein each said driving motor is coupled to the lower forming roller in each respective pair of complementary forming rollers.

4. Roll forming apparatus according to any one of the preceding claims, wherein each lower forming roller is fixedly located on said support frame.

5. Roll forming apparatus according to any one of the preceding claims, wherein there is provided a load sensing transducer associated with each said selected roll forming stations and associated control means for controlling the power output of said driving motors.

6. Roll forming apparatus according to any one of the preceding claims, wherein the complementary forming rollers of a roll forming station between a pair of said selected roll forming stations are freely rotatable about their respective axes.

7. Roll forming apparatus according to any one of the preceding claims, wherein said driving motors are hydraulic motors.

8. Roll forming apparatus according to any one of the preceding claims, wherein the forming rollers of some or all said roll forming stations have a body part formed of a resilient material fixed to a central spindle.

9. Roll forming apparatus according to Claim 8, wherein the rollers about which a bend is adapted to be formed in the workpiece include a resilient part which forces the adjacent portion of the workpiece against the complementary roller and a rigid disc fixed co-axially to said spindle and having a peripheral portion about which the workpiece is folded.

10. Roll forming apparatus according to Claim 9, wherein said resilient body portion extends radially outwardly beyond said rigid disc.

11. Roll forming apparatus according to Claim 9 or Claim 10, wherein said resilient body portion is formed from an elastomeric material having a hardness of between 80 to 120 durometer.

12. Roll forming apparatus according to Claim 11, wherein said elastomeric body has a surface finish of between RA 10 and RA 15.

13. Roll forming apparatus according to any one of the preceding claims, wherein there is provided shear means for shearing the workpiece and having a shearing blade which is slidable between and co-operates with longitudinally spaced shearing jaws.

14. Roll forming apparatus having a plurality of roll forming stations and drive means for actuating the roll forming stations wherein the forming rollers in each or some of the roll forming stations each include a spindle having a resilient body supported thereon.

15. Roll forming apparatus according to Claim 14, wherein said resilient body is formed from an elastomeric material having a hardness of between 80 and 120 durometer.

16. A forming roller for roll forming apparatus as defined in any one of the preceding claims, including a spindle and an elastomeric body supported on said spindle.

17. A forming roller for roll forming apparatus, including a spindle; a rigid disc supported co-axially about said spindle; a resilient cylindrical body supported about said spindle and extending along said spindle from said disc and extending radially outwardly beyond said disc.

18. A forming roller according to Claim 17, wherein said disc is formed of metal and said body is formed of a relatively hard elastomeric material.

19. Roll forming apparatus substantially as hereinbefore described with reference to the accompanying drawings.

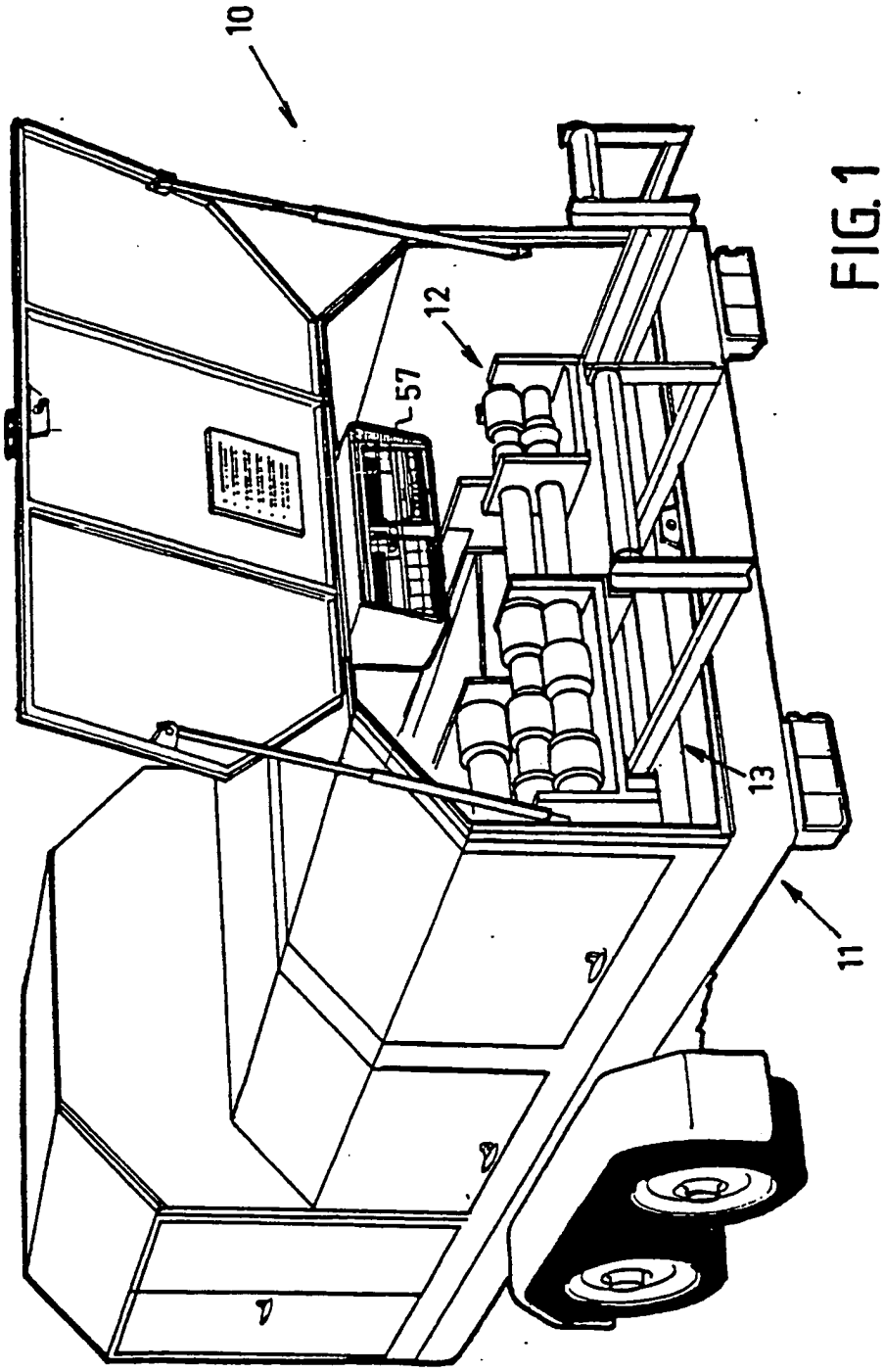
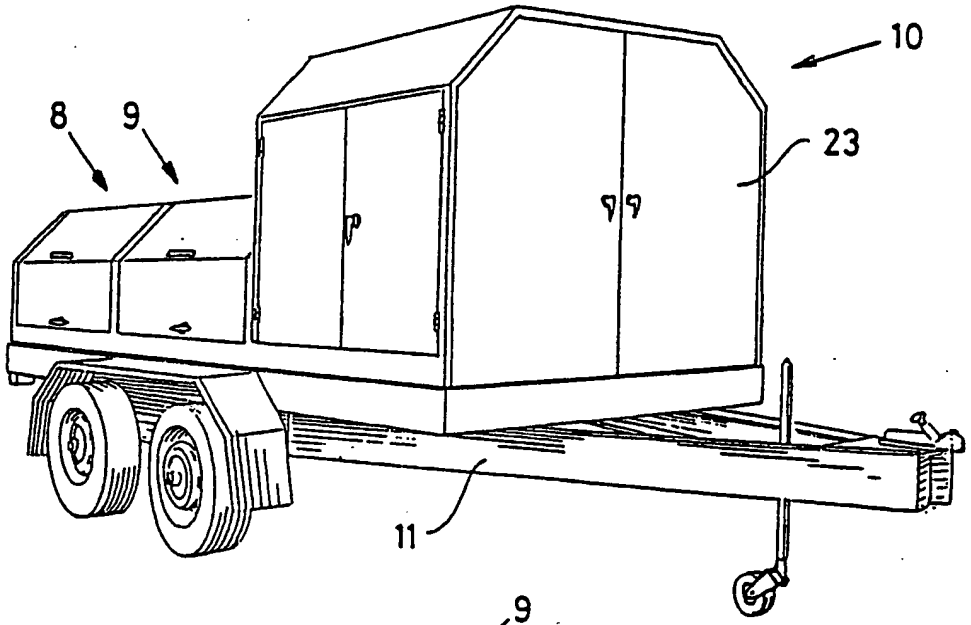


FIG.1

FIG. 2



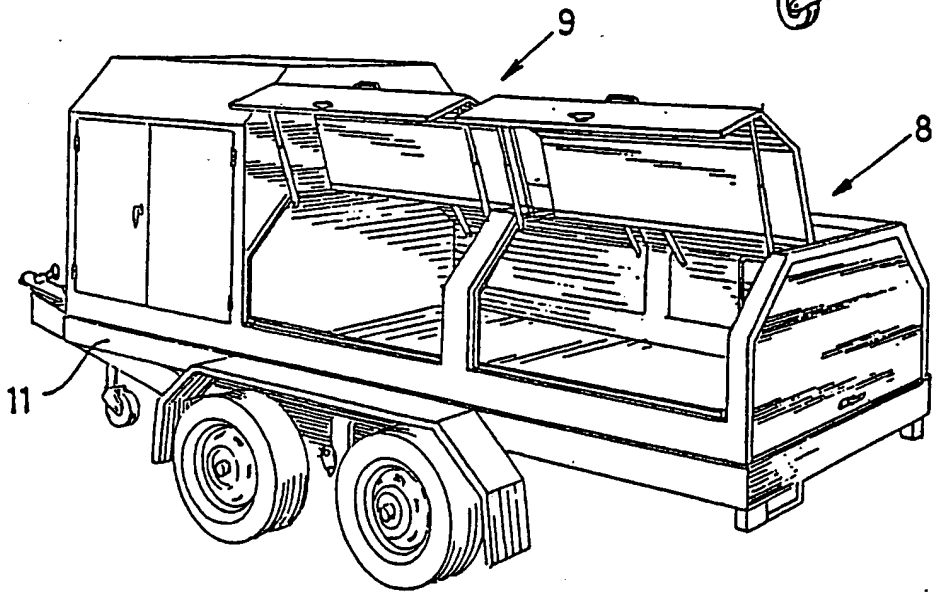


FIG. 3

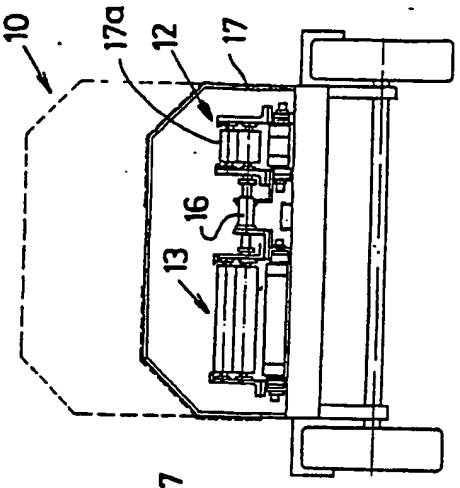


FIG. 5

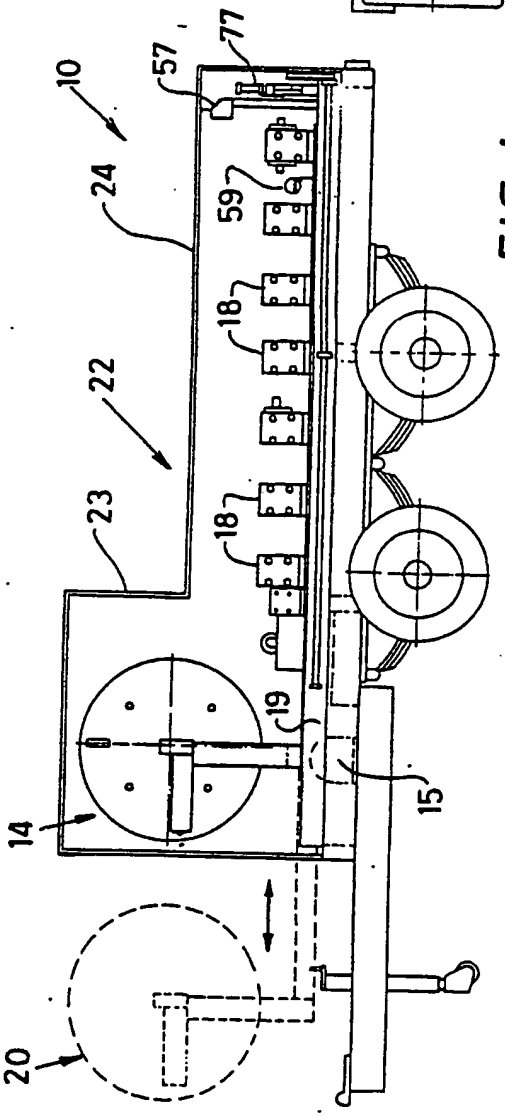


FIG. 4

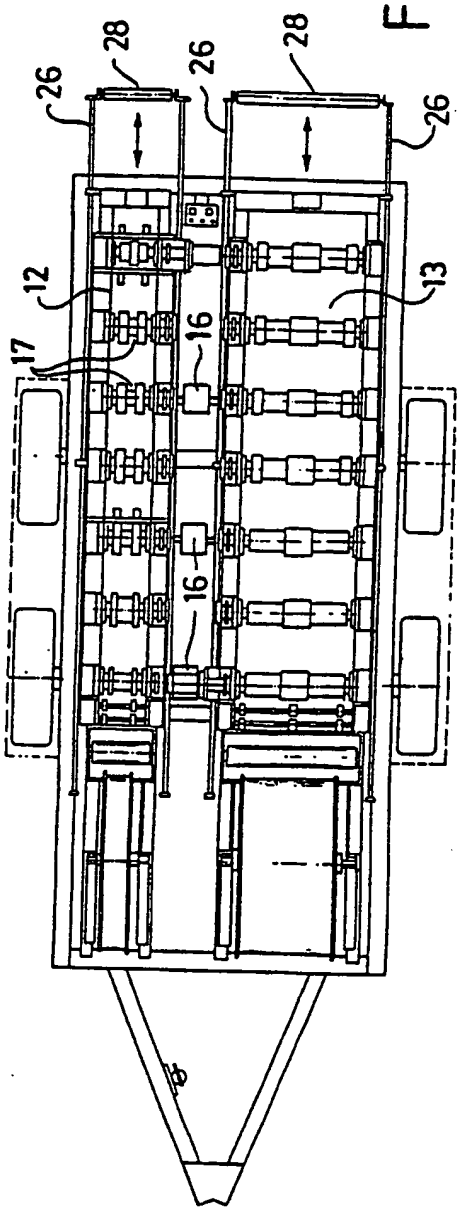


FIG. 6

SUBSTITUTE SHEET

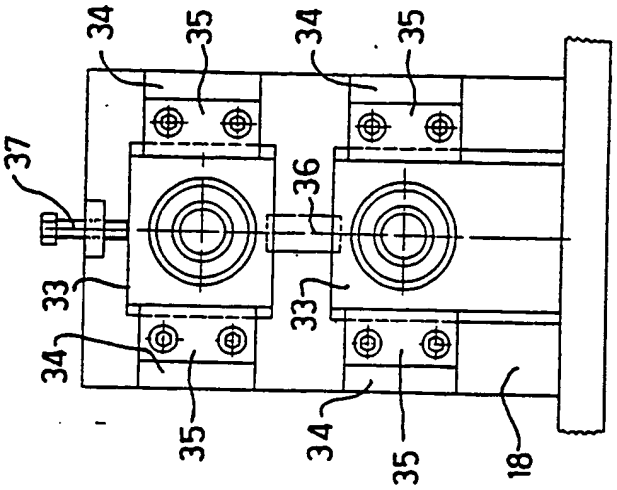


FIG. 8

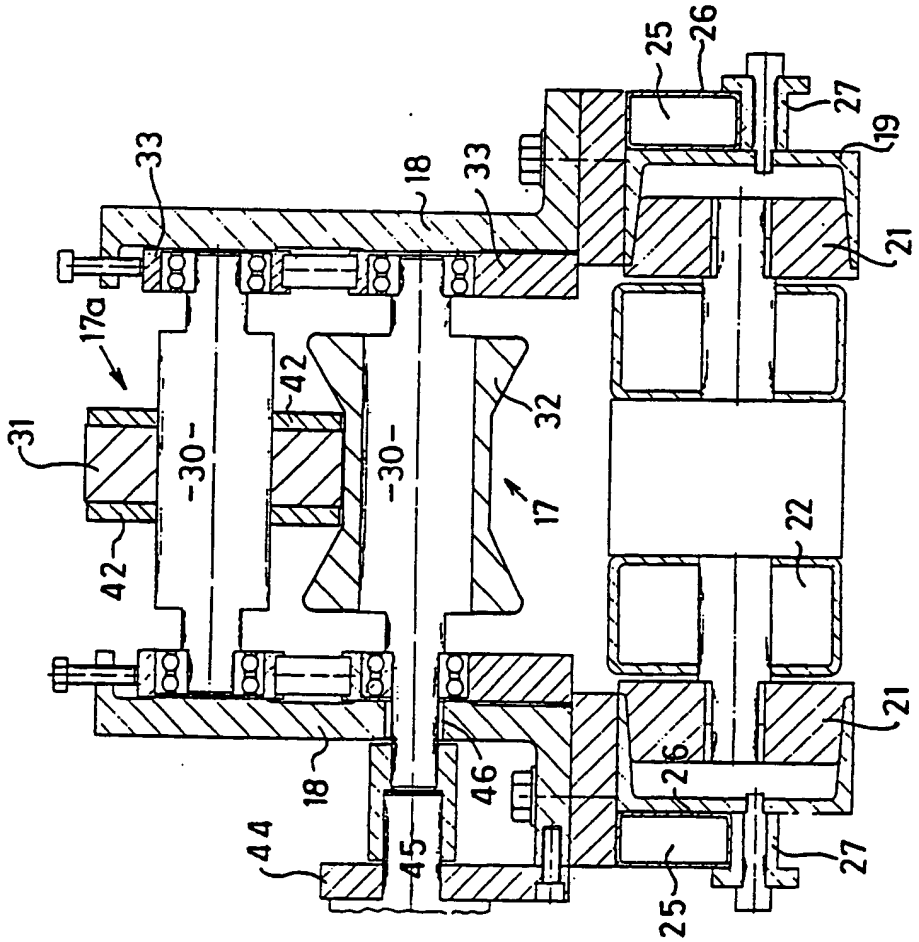


FIG. 7

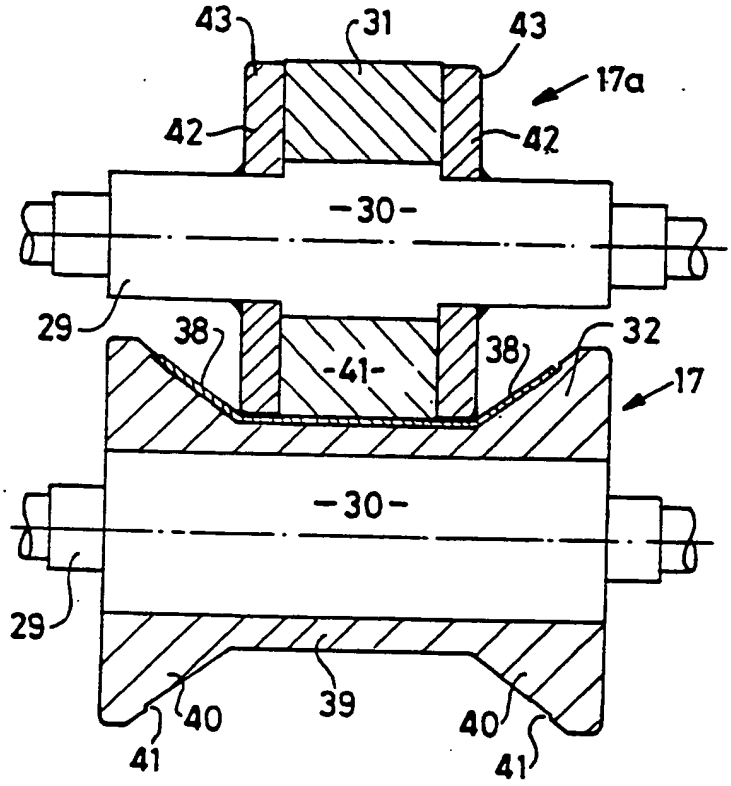


FIG. 9

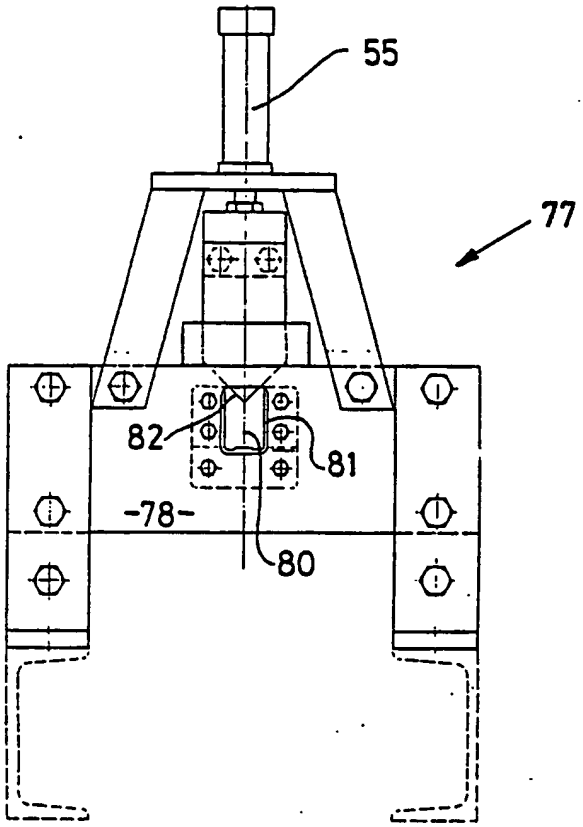


FIG. 11

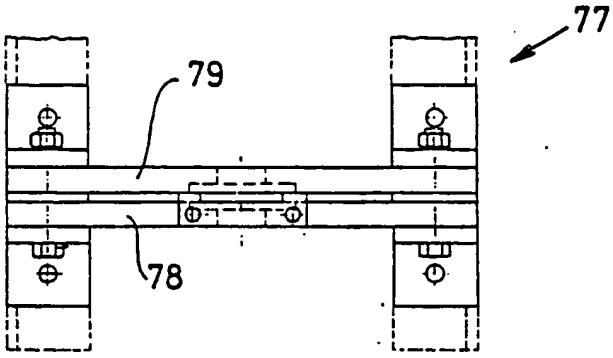


FIG. 10

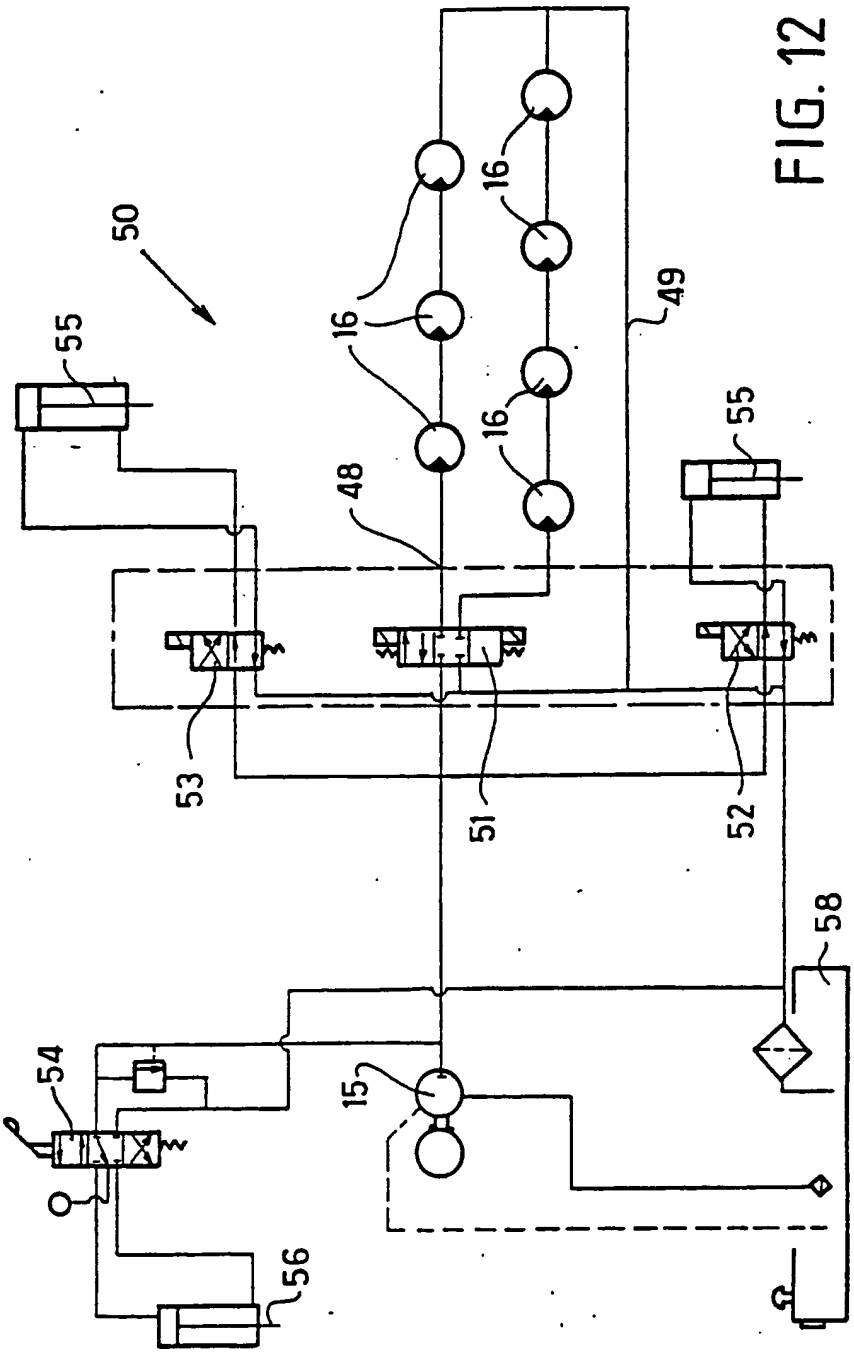


FIG. 12

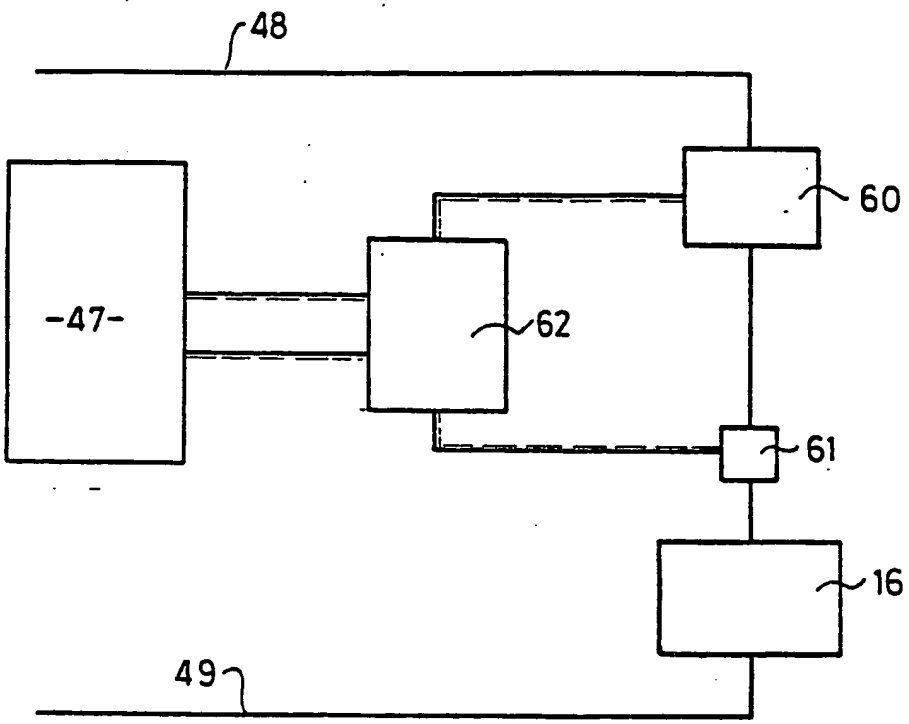


FIG. 13

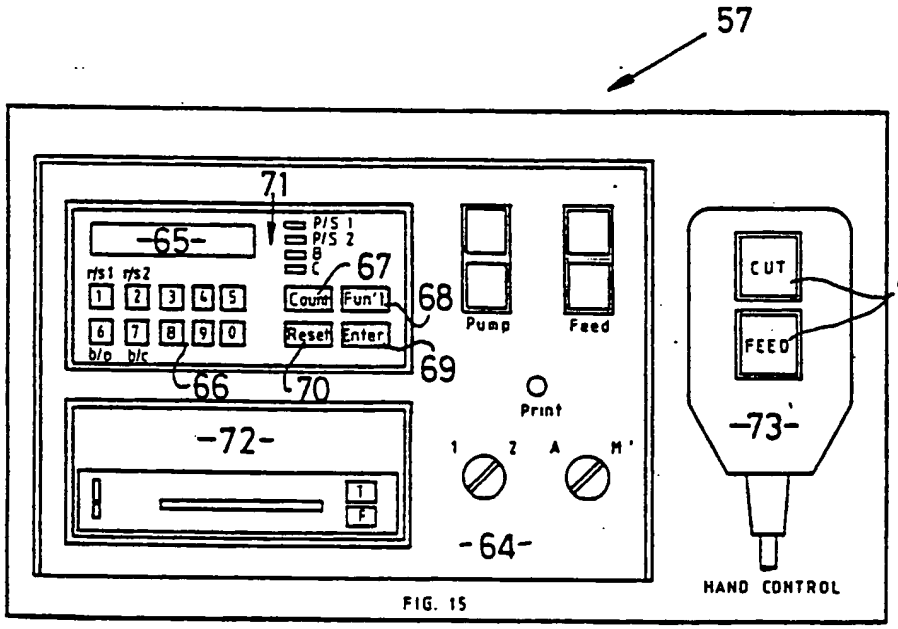


FIG. 15

FIG. 14

SUBSTITUTE SHEET

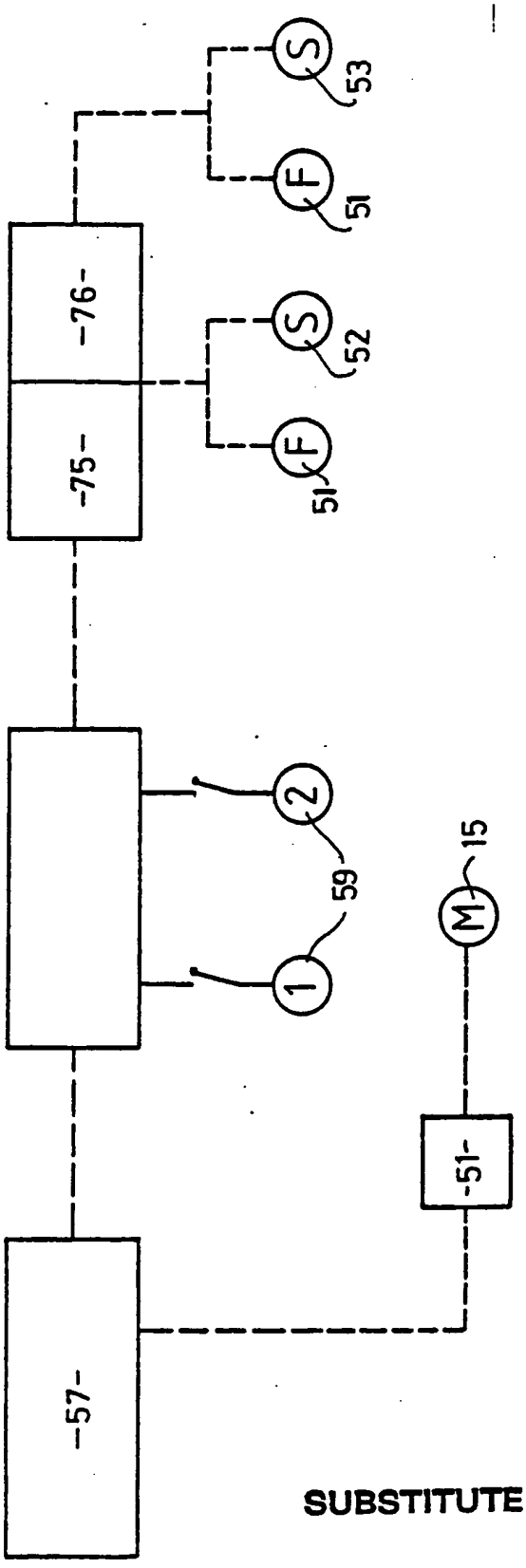
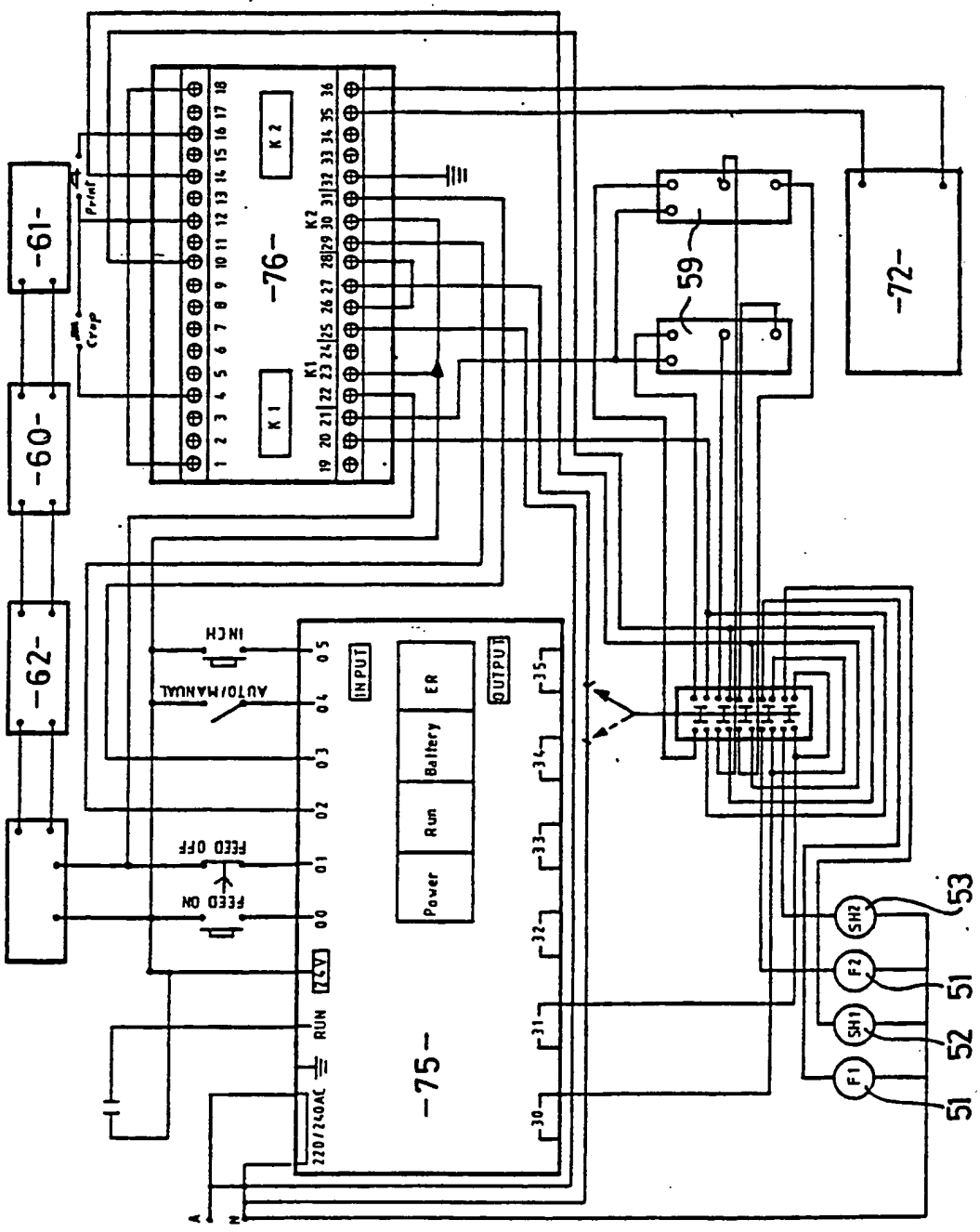


FIG. 15

SUBSTITUTE SHEET

FIG. 16



INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 86/00306

I. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[4] B21D 5/08

II. FIELDS SEARCHED

Minimum Documentation Searched

Classification System	Classification Symbols
IPC	B21D 5/08

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched

AU : IPC as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
Y	US,A, 1694495 (TRAFELET) 11 December 1928 (11.12.28)	(14,16)
Y	US,A, 2020042 (RUBIN) 5 November 1935 (05.11.35)	(1-4)
Y	US,A, 2799317 (TOULMIN) 16 July 1957 (16.07.57)	(14,16)
Y	US,A, 3006224 (CELOVSKY) 31 October 1961 (31.10.61)	(1-4,7)
Y	US,A, 3080838 (NASH) 12 March 1963 (12.03.63)	(1-4,7)
Y	US,A, 3535903 (ABERNATHY and LINDSAY) 27 October 1970 (27.10.70)	(1,8,14,16,17)
Y	US,A, 3756057 (BROOKS, DAVIS and HENRY) 4 September 1973 (04.09.73)	(1,14,16)
Y	US,A, 4112722 (BOUCARD) 12 September 1978 (12.09.78)	(1-4,7)
X	FR,A, 2539655 (BEAUPLAT) 27 July 1984 (27.07.84)	(14-18)

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
8 January 1987 (08.01.87)	(29.01.87) 29 JANUARY 1987
International Searching Authority: Australian Patent Office	Signature of Authorized Officer: D.G. FRY

Form PCT/ISA/210 (second sheet) (January 1985)